T-1011 Run Summary

Tests of radiation-hard silicon microstrip sensors for CMS in S-LHC

CMS Tracker

Pixel region (R<20cm)

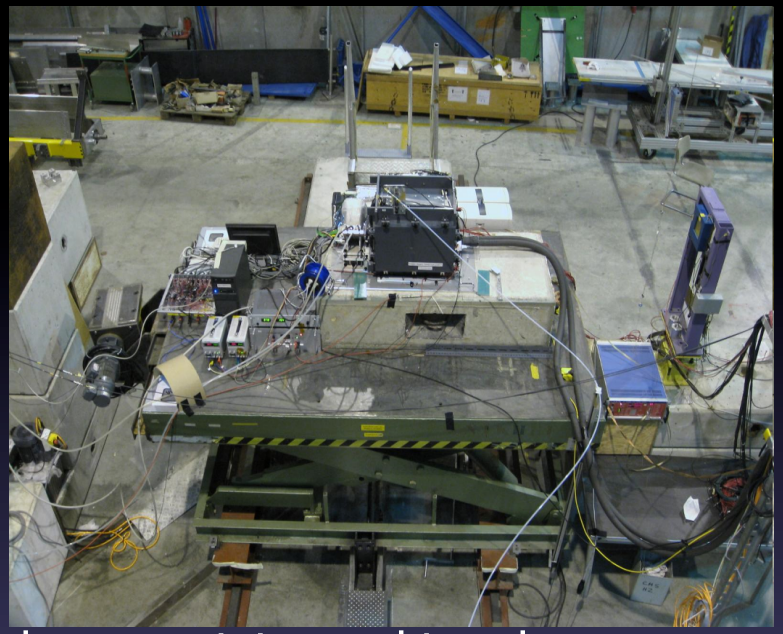
- Barrel , Forward
- 66M channels!
- PSI46 chip
  - 52 x 80 pixels
  - Sparcified at ROC
- Replacement in S-LHC phase I (and II)
  - 10^{16} 1 MeV n_{eq}
- Beam telescope at FNAL based on CAPTAN system
  - ~1 cm^2 beam spot required

Strip region (R>20cm)

- TIB, TID, TOB, TEC
- 200 m^2 sensor area!
- APV25 chip
  - 128 channels
  - Sparcified at FED
- Replacement in S-LHC phase II
  - 10^{15} 1 MeV n_{eq}
- Beam telescope at CERN (and now FNAL!) based on APV hybrids, CMS DAQ
  - Designed for 4x4 cm^2 beam spot

Two separate test beam efforts

Silicon Beam Telescope (SiBT) Group



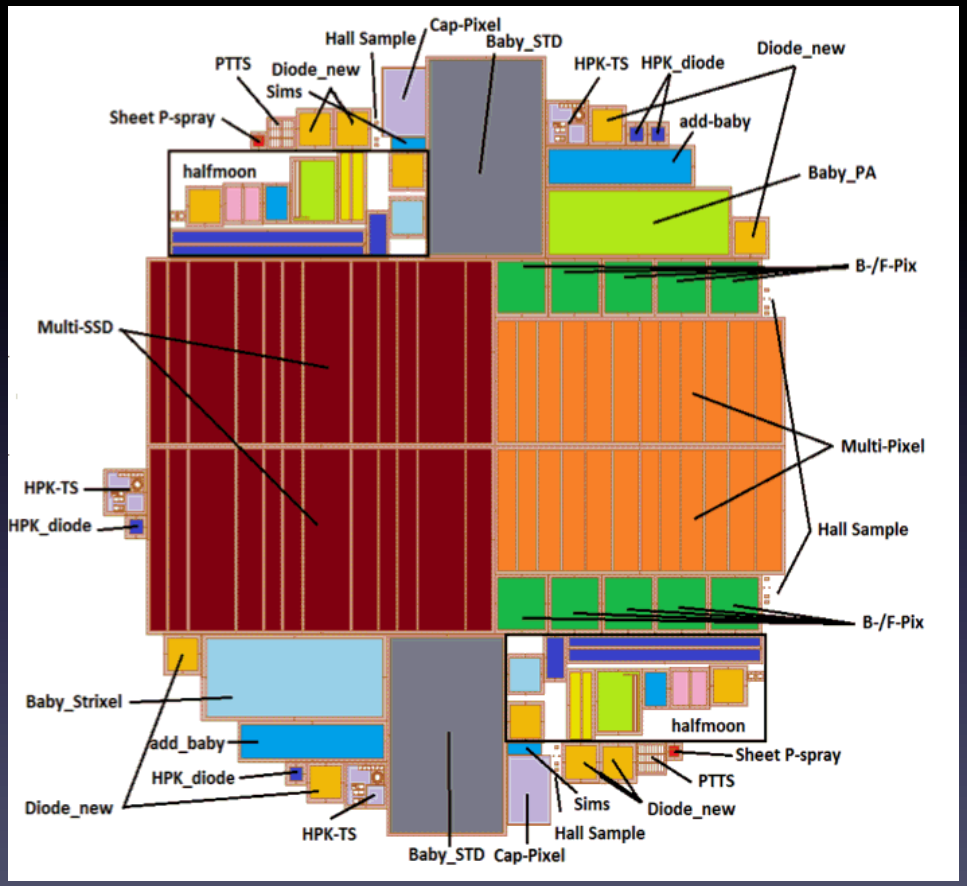
- The SiBT group has participated in 5 beam tests in the CERN H2 line since 2007
  - Original focus was to explore Magnetic Czochralski silicon as a rad. hard option for S-LHC strip tracker regions.

http://www.hip.fi/research/cms/tracker/SiBT/php/home.php

T-1011 Personnel

- Brown University
  - A. Garabedian, D. Tersegno
- CERN
  - G. Auzinger
- FNAL
  - L. Spiegel
- HIP (Helsinki Institute of Physics)
  - D. Fusi, P. Luukka, T. Mäenppää, (H. Moilanen), T. Peltola, E. Tuovinen
- KIT (Universität Karlsruhe)
  - K. Hoffman
- Wayne State University
  - P. Lamichhane

CMS HPK Campaign



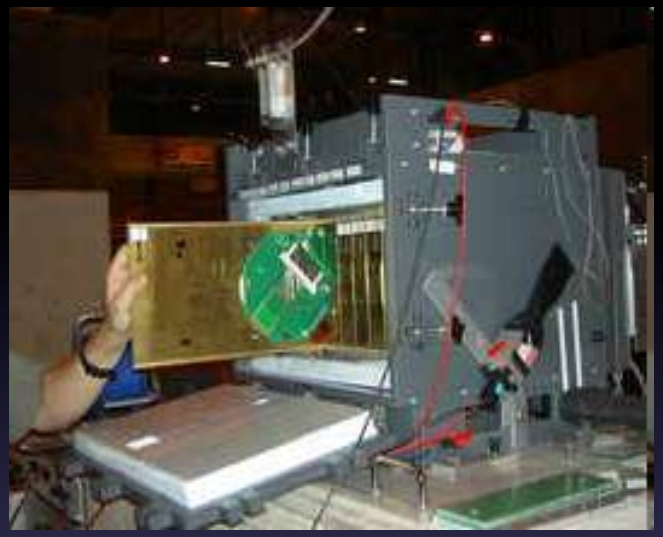
Over 100 6 inch wafers
Silicon technologies: Float Zone, Magnetic Czochralski, Epitaxial
Thicknesses: 320, 200, 120, 100, 70, 50 microns
Bulk doping: n-type, p-type (p-stop, p-spray)

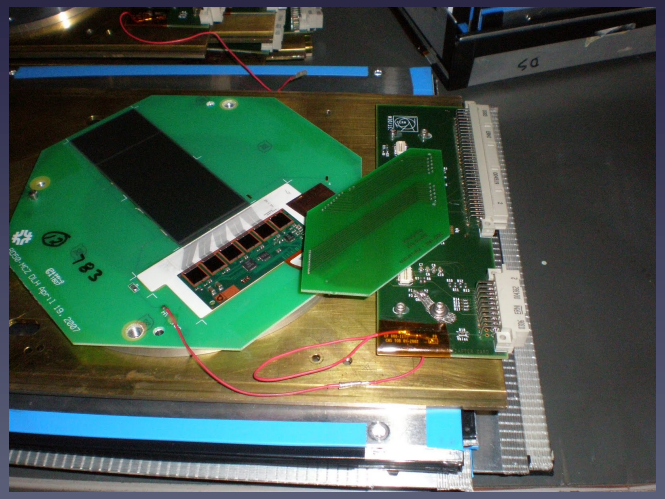
Timeline

- March 15 – Received beam telescope late in afternoon after hang-up with DHL/O'Hare resolved
- March 18 – Safety approval
- March 19 – Commissioning
- March 20 – Start taking data with first set of DUTs
- March 23 – Double spills starting in the afternoon!
- March 24 – No beam all day
- March 27 – Main program completed. Install "time permitting" modules

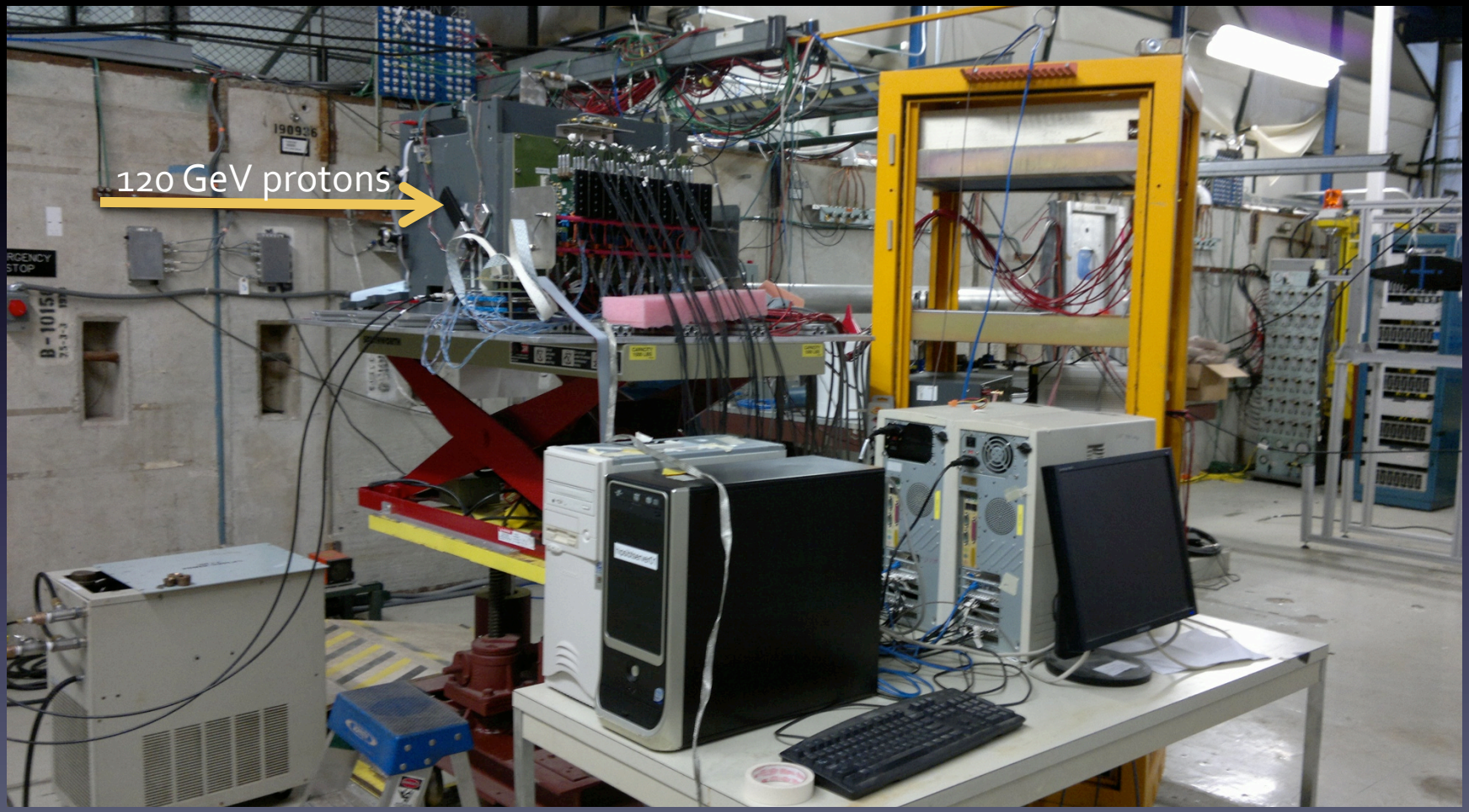
Silicon Beam Telescope

- Redeployed CMS "Vienna" system
- Telescope includes 4+4 reference planes and 2 DUT slots
- Modules typically installed in ±45° orientations due to height limitation
- Reference detectors are DO Run IIb HPK sensors (60 µm pitch with intermediate strips, 639 channels)
- Telescope active area is 4 x 4 cm^2.
- Readout electronics: CMS (TOB) hybrids
- DAQ software is a modified version of XDAQ



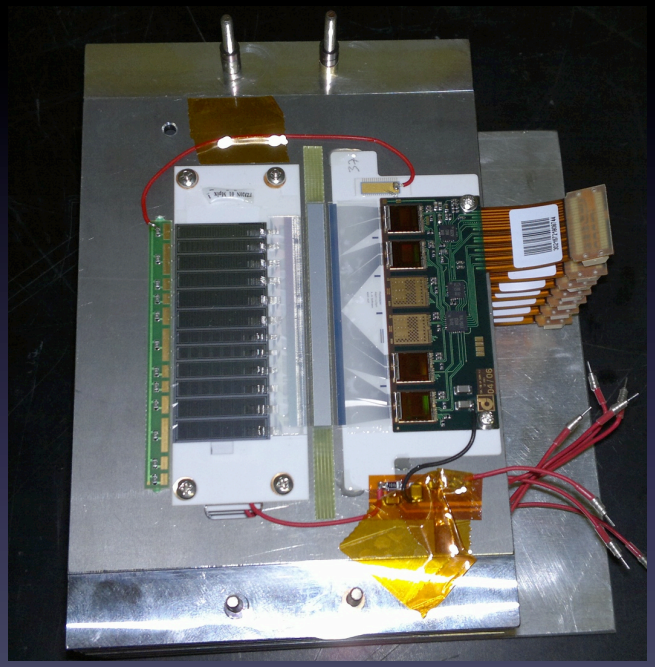


SiBT@FTBF



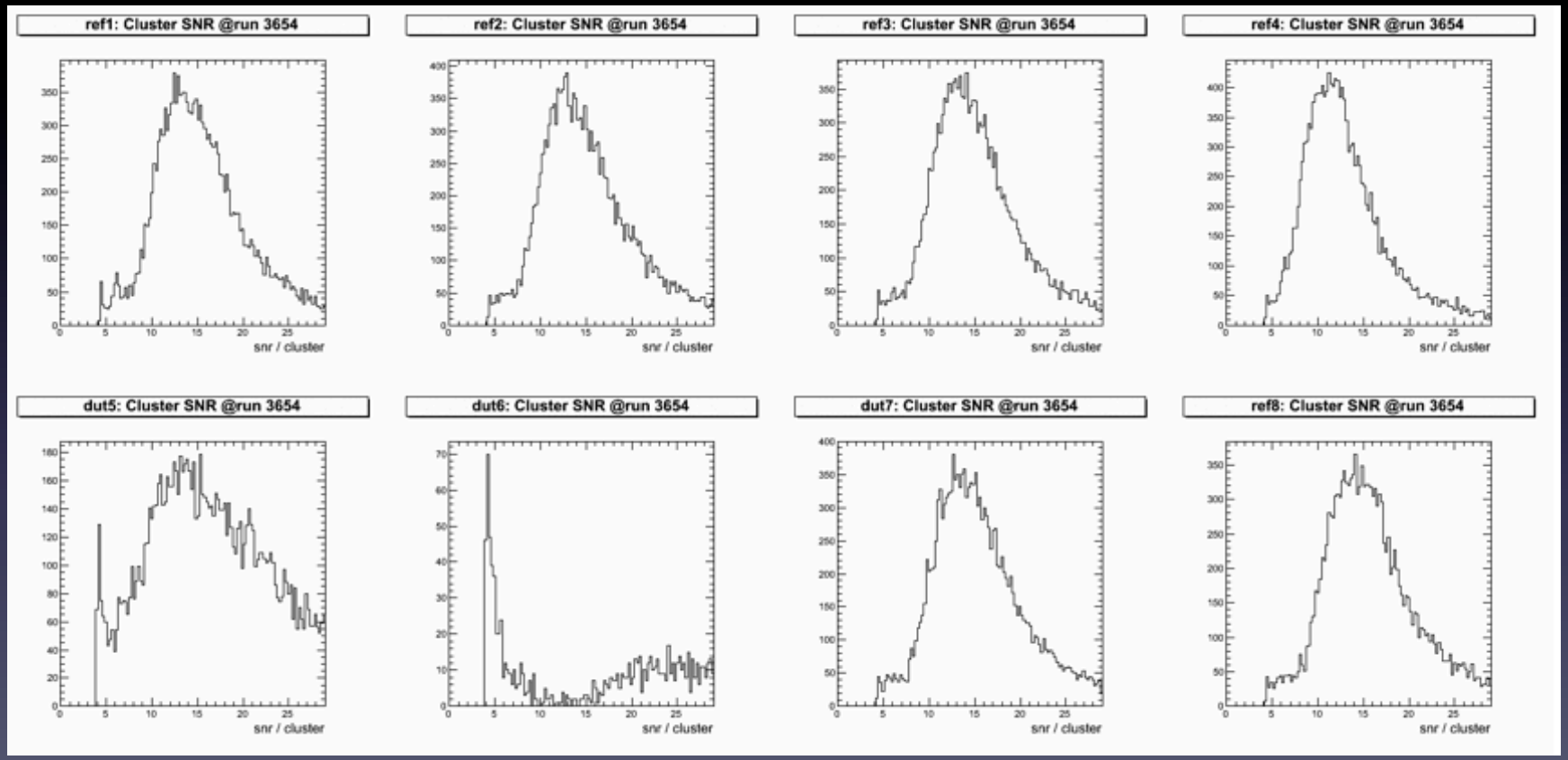
MSSD and Mpixel Modules

1)	FZ320N_08_MSSD_1	FZ200N_06_Mpix_1
2)	FZ320P_01_MSSD_1	FZ320N_01_Mpix_1
3)	FZ200N_01_MSSD_1	FZ320P_04_Mpix_1
4)	FZ120N_02_MSSD_2	FZ120N_06_Mpix_1
5)	FZ320Y_04_MSSD_2	FZ320Y_05_Mpix_2
6)	FZ200P_04_MSSD_1	FZ200P_01_Mpix_2
7)	FZ200Y_02_MSSD_2	FZ220Y_02_Mpix_2
8)	E100N_02_MSSD_1	E100N_02_Mpix_1
9)	E50N_02_MSSD_1	E50N_02_Mpix_1



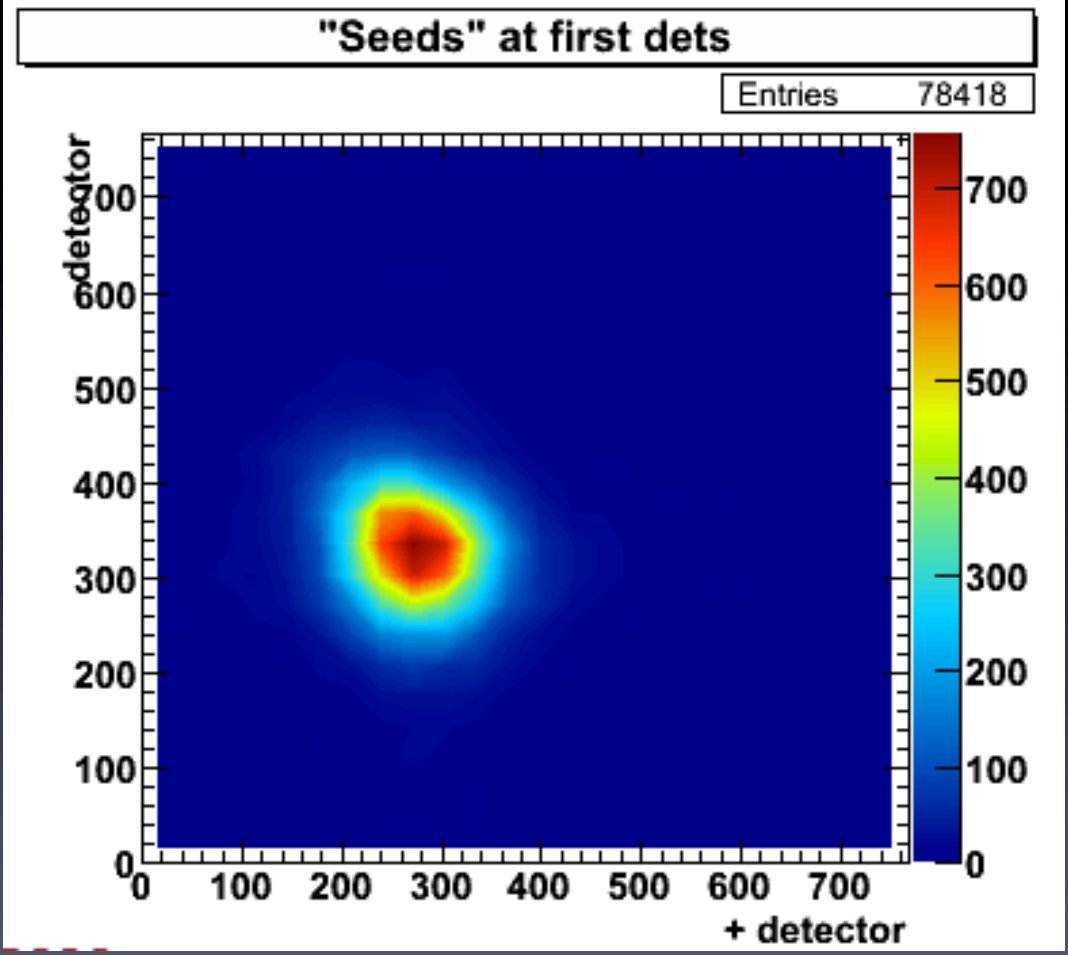
Online Monitoring

Ref. 1 Ref. 2 Ref. 3 Ref. 4



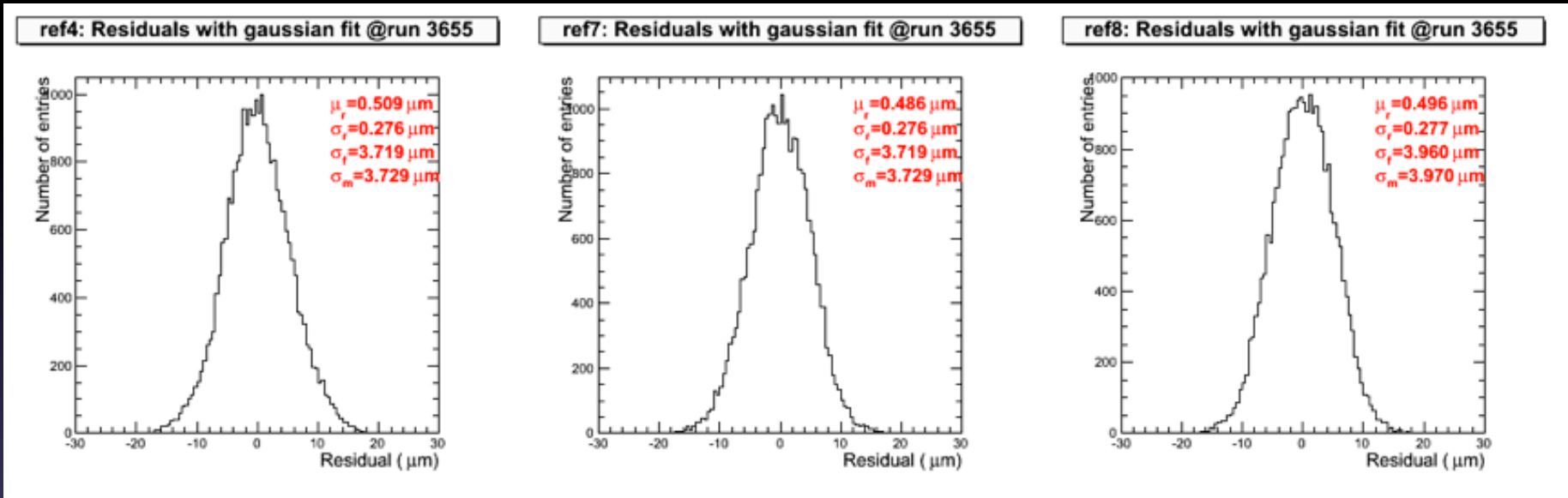
DUT 1 DUT 2 Ref. 5 Ref. 6

Online Beam Spot



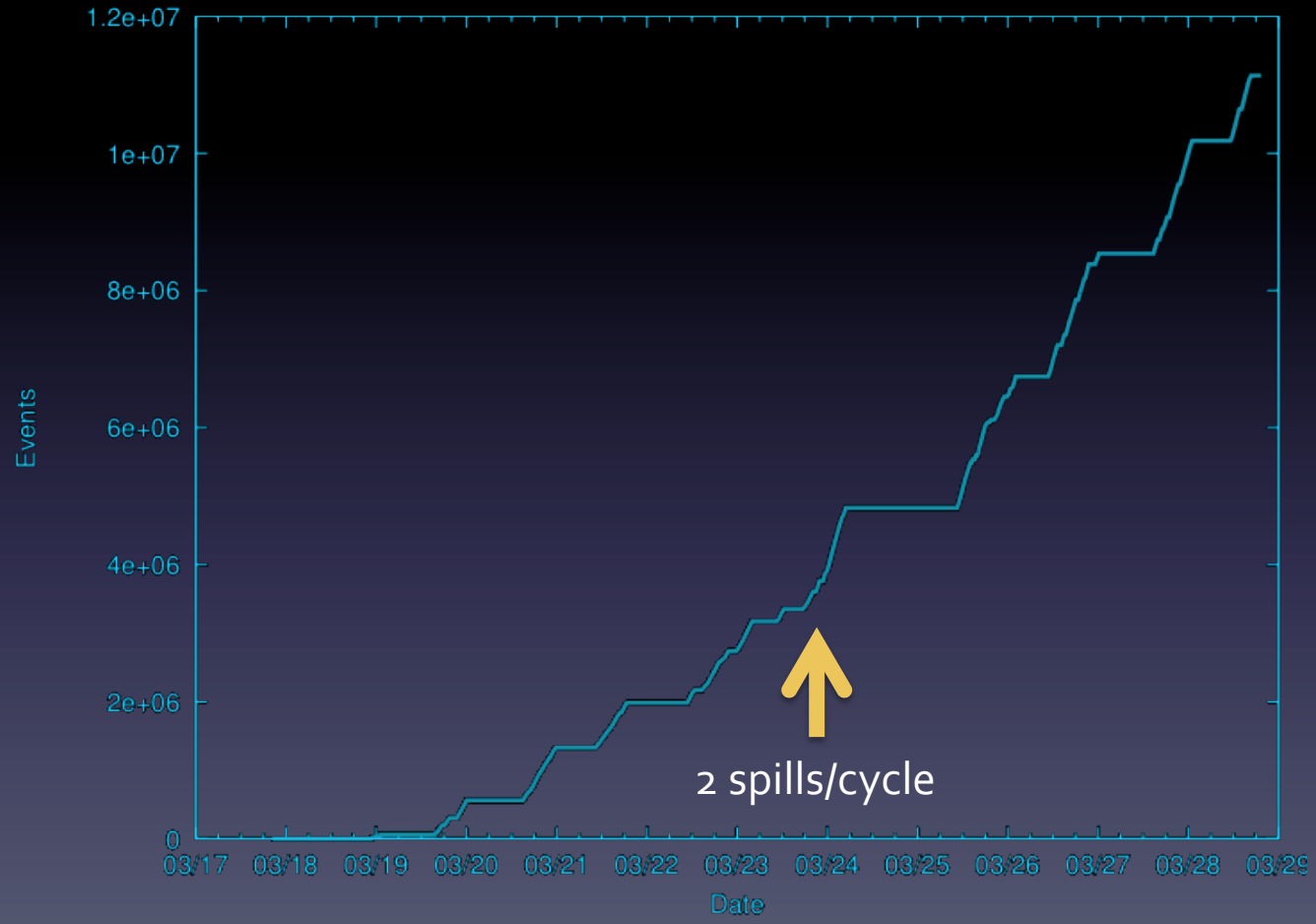
~1 cm² beam spot, preferred by primary user (T-992), required 7 table positions per voltage setting to cover 12 distinct regions per MSSD/Mpixel module.

Offline Alignment



Reference planes are aligned for each run (50k triggers) and this work will be done at Helsinki in the near future.
The interpolation accuracy at slots 5 and 6 (DUT stations) is 4 μm.

E vent Accumulation



As of yesterday afternoon

Thanks!

- The T-1011 group would like to express their gratitude for the many people at Fermilab who helped make the test beam run a success. In particular, we note the promptness in which the Lab responded to a request to double the number of spills per cycle. Without this change we would not have been able to complete our program.